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LEAD WARFIGHTERS AND INNOVATIONS: COLLABORATIVE METHODS OF FILLING CAPABILITY GAPS

by

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Preface

In February 1999, I returned to the states from an overseas assignment at Aviano Air Base, Italy. While sitting in my cubicle at Wright-Patterson Air Force Base 30 days later I heard on the news that the first bombs had just been dropped in Kosovo. A feeling of helplessness overwhelmed me as I realized the unit I just left, the world-famous, highly-respected, Triple Nickel Fighter Squadron, was dropping bombs in anger; and here I was, sitting in a cubicle in Dayton, Ohio. After three years of leading some of the Air Force's finest maintenance troops at the pointy end of the spear, I was on the bench for game day—what a bummer. Soon, however, I realized I had it all wrong. It was not about me, it was not about which operations I was participating in or which ones I was sitting out. I realized that regardless of where I physically sat, or which job I was currently doing, what I needed to be concerned with was how well I was supporting the Air Force team.

So I accepted my fate as an acquisition professional and decided that I would spend the rest of my Air Force career doing all that I can to support the warfighter. Since then, I have been fortunate enough to serve in positions which have provided me a better understanding of the important role the acquisition community plays in shaping tomorrow's battlespace. I have also been exposed to the important role the acquisition professional plays in prosecuting today's war, and it is this aspect of warfighter acquisition support that this paper explores.

Supporting the warfighter during combat operations can be the most exciting aspect of the acquisition world. Every war has a set of unique circumstances, and we can count on having to

overcome deficiencies or capability gaps during each conflict. From the warfighter's perspective, this is where the acquisition professional makes his money—being able to rapidly plug those gaps. For the acquisition professional, this is where the rubber meets the road in directly impacting on-going combat operations. I will assure you, nothing gets the blood moving faster than rapidly producing combat capability for America's warriors!

I have received tremendous support from a whole host of people, and while I risk leaving someone out, I wish to send special thanks to several who have gone above and beyond.

First, I wish to thank God, who guides and mentors me 24/7. I am most grateful that He has given me a unique purpose for my life and pray that my work supports His desires.

Many thanks to Lt Gen Dick Reynolds, who sparked the idea for this project by asking me to look into the impacts of "slam-dunking ACTDs into operations," and to Maj Ross McNutt for introducing me to Eric von Hippel's work on the sources of innovation. Von Hippel's work made me focus on the lead warfighter concept, which ultimately tied my other ideas together.

Special thanks to my advisor, Lt Col Courtney Holmberg, for his patience and tutelage. His mentorship, attention to detail, and commitment to excellence vastly enhanced the quality of this project. Should this paper add to the thinking of how the acquisition community can better support the warfighter during times of conflict, it does so largely because of Lt Col Holmberg. Any shortcomings of this work are my own.

Finally, my heartfelt thanks to my wife Melanie, son Jacob, and daughter Lia, for their never-ending patience and understanding. This project often took time away from them; time they certainly deserve, yet, so graciously gave up to support me in my professional endeavors—thank you very much!

Abstract

Each war has a set of unique contextual elements that make it different from the wars of the past; thus, preparing for war will inevitably uncover capability gaps and deficiencies in warfighting capability. This paper explores the methods used by the Air Force acquisition community during combat operations to fill those gaps, with a specific concentration on developing and employing immature systems via the rapid response process (RRP).

New concepts, such as effects-based operations (EBO) and evolutionary acquisition have the potential to enhance the acquisition professional's ability to support the warfighter during times of conflict. EBO will enhance the war planner's ability to highlight capability gaps, and with increased collaboration, the warfighters and acquisition professionals can work together to produce enhanced warfighting capability. Evolutionary acquisition, through spiral development, will speed up the acquisition process and provide more options for filling capability gaps.

Underlying each of these concepts is the premise that the Air Force is able to innovate. Undoubtedly, the Air Force can innovate; however, research shows that modifications to current organizations are required to maximize the Air Force's most important source of innovation—the lead warfighters. These modifications will enhance collaboration between the acquisition professionals and the lead warfighters to ensure the Air Force is capitalizing on this important source of innovation.

Chapter 1

Introduction

Everything in war is very simple, but the simplest thing is difficult.

—Carl Von Clausewitz

One year after declaring war on terrorism and launching Operations Enduring Freedom and Noble Eagle, President Bush signed the FY2003 National Defense Authorization Act (NDAA). This act accomplished two critical tasks. First, the bill provided authorization and direction for spending the $355 billion dollars appropriated to the DOD for FY2003. Second, Congress used the appropriations act to communicate policy to the DOD regarding personnel, acquisition, research and development, the procurement of weapon systems, decorations, awards, and training programs. Buried deep in the act are two sections that should be of particular interest to the warfighters, especially those currently involved in Operation Iraqi Freedom.

Sections 806 and 807 of the NDAA directs the Secretary of Defense to establish a quick-reaction special projects acquisition team, along with procedures to rapidly acquire and deploy weapon systems.[1] The inclusion of these sections indicates the importance of formalizing and standardizing procedures for rapidly acquiring and deploying weapon systems; it also indicates that some do not believe the DOD is currently accomplishing this task as effectively as it could. Perhaps, this is a result of the many stories brought home from recent operations in Afghanistan, where rapidly acquired systems proved critical to successful operations. On the other hand, it

may be an awakening to the age-old theory that tomorrow's war will likely be much different from yesterday's war, and therefore, regardless of how much one prepares, there are sure to be surprises. Regardless, the direction is clear: ensure your processes are in place so that you can rapidly acquire and deploy urgently needed weapon systems to react to an enemy threat or respond to significant and urgent safety situations.[2]

This paper will explore the methods used by the Air Force acquisition community to fill capability gaps and solve deficiencies during combat operations and assess their viability for the future. It is intended to contribute to the on-going discussions regarding how the acquisition community can rapidly develop and employ new technology and immature systems in support of warfighters' needs during conflict. It will examine the process the USAF uses to rapidly produce combat capability, paying particular attention to the use of immature systems. The paper will assess this process in light of current thinking on innovation, effects-based operations, and evolutionary acquisition. The ultimate goal is that the conclusions drawn and recommendations developed from this research will assist the USAF acquisition community in better supporting the warfighters during times of conflict.

Filling the Gap: Historical Examples

Every war has a set of unique contextual elements that make it different from wars of the past; thus, preparing for war is always a difficult task. Nevertheless, the U.S. does its best to train and equip warfighters with advanced weapon systems to assist in obtaining decisive victory. Unfortunately, no matter how well the U.S. prepares, "there is a zero percent chance that we have this one hundred percent right."[3] Those areas where U.S. preparation falls short in "getting it right" are the very areas the enemy can most successfully exploit. If the warfighters can determine ahead of time where a shortfall might exist, it may be possible to fix it ahead of time.

The difficulty, however, is that shortfalls are not always easy to detect before a conflict begins. Additionally, it is prudent to remember that the enemy is a living, thinking opponent who is continuously looking to exploit small, overlooked gaps in U.S. preparation for war.

Clausewitz noted this when he said, "War…is not the action of a living force upon a lifeless mass…but always the collision of two living forces."[4] Stated another way, each opponent is doing their best to determine the other's weak points. For this reason, the U.S. must have the ability to quickly acquire and deploy new capabilities, so that once gaps or deficiencies are recognized, they can be rectified quickly. Herein lies the benefit of Congress including Sections 806 and 807 in the FY2003 NDAA.

History is replete with examples where the U.S. armed forces discovered their preparation for war fell short, and new capabilities were required. A look at the beginning of the strategic bombing campaign in World War II is a perfect example of how the enemy exploited gaps in U.S. capabilities. Following the interwar period, the Air Corps Tactical School (ACTS) developed the industrial web theory and the supporting doctrine of unescorted, high altitude, daylight precision bombing. Air War Planning Document 1 (AWPD-1), the first comprehensive document on airpower employment, used the ACTS doctrine as its foundation. This doctrine assumed that unescorted bomber formations could defend themselves through massed firepower. This assumption, of course, proved to be fundamentally flawed, and eventually it was the rapid acquisition and deployment of the long-range escort fighter, the P-51 Mustang, that saved the US bomber fleet from total destruction.[5]

Other classic examples of capability gaps filled by rapid acquisition and deployment of new systems occurred in Vietnam. Having not paid attention to the lessons from Korea, in combination with the growing cold war environment that followed World War II, the Air Force

prepared to fight its next war with weapon systems designed to conduct strategic nuclear bombardment. As a result, many gaps in the U.S. military's warfighting capability became apparent upon entering the Vietnam War. For example, the F-105, designed as a nuclear-attack fighter, was not well suited for combat and was incredibly vulnerable to anti-aircraft fire. The assumption was that "nuclear raids on enemy airfields combined with air superiority would guarantee the Thunderchief a safe operating environment."[6] When pressed into action in a conventional role, the glaring capability gap of the F-105 ineffectiveness and inability to operate in the high threat environment of Vietnam was evident. To rectify this problem, the USAF intended to replace the Thunderchief with the F-4; however, early models lacked an internal cannon. This made the F-4 virtually incapable of defending itself against enemy fighters, subsequently diminishing its ability to be a satisfactory air superiority fighter.[7] Eventually, future models of the F-4 were modified to include internal cannons.

While the F-105 and F-4 limitations resulted in reduced effectiveness, and therefore a gap in their capabilities, it was the introduction and subsequent use of the SA-2 surface-to-air missiles (SAM) by the North Vietnamese that proved to be a real problem. While the north had begun installing SA-2s in 1965, the U.S. was convinced that they would not use the SAMs since restrictive rules of engagement kept the U.S. from bombing their main cities. Clearly, the USAF understood the danger of these systems as the Soviets had already shot down two U-2s; nevertheless, they chose to ignore the potential threat. Then, in July 1965, "the first American jet fell to a surface-to-air missile."[8] Following this shoot down, the U.S. lost eight more aircraft over the next four months while attempting to suppress the SAMs.[9] It quickly became apparent that suppressing the SA-2 was a capability gap. Utilizing rapid acquisition and modification of commercial-off-the-shelf (COTS) equipment, the USAF began the Wild Weasel program by

modifying F-100Fs to find and negate the SAM threat. Within four months the system was operational and "successful, destroying nine SAM sites and freeing packages from the SAM threat by forcing the SA-2s off the air."[10]

There are many more examples where capability gaps discovered during combat operations were subsequently filled with rapid acquisition. Recent examples such as Predator, Global Hawk, E-8C Joint Surveillance Target Attack Radar System (Joint STARS), the Bunker Buster, special operation radios, and laser range finders have all proven essential to fighting the modern day war. Each of these systems has garnered high praises from the warfighter regarding the new or enhanced capabilities they provide, and in some cases, these immature systems were reported to have been critical to successfully completing the mission. It is obvious that filling capability gaps and deficiencies is essential to the U.S. maintaining the edge during combat. Therefore, it is incumbent on the acquisition community to examine their processes and continuously improve their support to the warfighter during combat operations.

The remainder of his paper will examine the processes the USAF uses to fill capability gaps and deficiencies during times of conflict, paying particular attention to the use of immature systems. In addition to examining how the current rapid response process operates, it will also assess this process in light of current thinking on effects-based operations, evolutionary acquisition, and innovation. Chapter 2 focuses on the materiel solution as a course of action available to warfighters when a capability gap is discovered. It establishes the concept of using immature systems as solutions, and details the Air Force's rapid response process. The chapter ends with a discussion on advanced concept technology demonstrations (ACTDs) and their usefulness in filling capability gaps.

Chapter 3 shifts the focus to ongoing Air Force efforts meant to improve its warfighting capability. This chapter analyzes effects based operations (EBO) and demonstrates how EBO combined with the rapid response process will have a positive impact on the ability of the acquisition community to support the warfighters during combat operations. Chapter 3 concludes with a brief look at acquisition transformation, paying particular attention to spiral development and how this strategy supports rapidly acquiring systems by providing a wider range of available solutions for the warfighter. Chapter 4 investigates some of the latest research on innovation. Using research recently completed at the Massachusetts Institute of Technology (MIT), this chapter analyzes the various sources of innovation within the Air Force and examines how the Air Force might better capitalize on those sources. Chapter 5 summarizes the paper and provides conclusions and recommendations for senior leadership consideration.

Notes

[1] House, *Bob Stump National Defense Authorization Act for Fiscal Year 2003*, 107th Cong., 2nd sess., 2002, H.R. 4546, Sections 806/807.

[2] Ibid., Section 806

[3] Gen Jumper has said this quote at numerous venues. One location where it can be found is: Sandra I. Erwin, "Gen Jumper: Time to Change Traditional Program Advocacy" *National Defense*, Jul 2002.

[4] Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, N.J.: Princeton University Press, 1976), 77

[5] Major H. Dwight Griffin, et al., Air Corps Tactical School: The Untold Story, Air Command and Staff College (Maxwell AFB, AL: May 1995), 45-46.

[6] Mark Clodfelter, *The Limits of Air Power: The American Bombing of North Vietnam* (New York: The Free Press, 1989), 31.

[7] Ibid., 133.

[8] Ibid., 131

[9] Lt Col Jeffrey E. Smith, "Operational Acquisition—An Oxymoron?" *Program Manager*, March-April 1999, 25.

[10] Ibid., 25

Chapter 2

Responding to Deficiencies and Capability Gaps

While the military departments are resourced to organize, train, and equip, they spend little on rapid acquisition.

—Sue C. Payton, Deputy Under Secretary of Defense for
Advanced Systems and Concepts

As discussed in the previous chapter, warfighters should expect that each war would have its own unique set of contextual elements that often result in the discovery of U.S. capability gaps or deficiencies. The good news is that once these gaps or deficiencies are discovered, there are several possible courses of action to remedy them. If the deficiency or gap is not critical enough to thwart the successful accomplishment of the warfighter's mission, the most prudent course of action may be to do nothing. If, however, the gap or deficiency is prohibiting the U.S. military from successfully accomplishing its objective, then doing nothing is not really a viable option. In this case, developing a non-materiel solution such as a change in tactics or techniques may be the best solution. The non-materiel solution is usually the quickest and least expensive (monetarily speaking) method for overcoming a deficiency or filling a capability gap; therefore, warfighters use it frequently. Airmen are well known for their creativity and innovation, and this quality serves them well in adapting and overcoming deficiencies using non-materiel solutions. In many cases, the deficiency may be corrected by simply changing a flight path, using an existing platform in a new manner, or re-packaging assets. However, there are times when a non-materiel solution is not a sufficient solution to the problem.

In the cases where doing nothing or developing a non-materiel solution does not work, it is time for the third option—a materiel solution. This option results in the employment of new systems. A materiel solution may consist of the employment of a system that has been in development for some time, a system that had previously been developed but shelved, or a system that is completely new. In any case, these systems typically are put together rapidly, undergo minimal testing, and can be costly in terms of time, money, and risk. Nevertheless, fielding these immature systems has become a mainstay in the way the Air Force solves many of its combat challenges, and it has proven to be a successful course of action.

Rapid Response Process

The primary method the Air Force uses to develop a materiel solution to a capability gap or deficiency is the Rapid Response Process (RRP). This process accelerates the fielding of a limited number of critical systems to meet theater-specific wartime needs. RRP typically does not equip "an entire fleet," only those assets employed in the theater. There are situations, however, where the entire fleet is involved in the conflict, and in those cases, the entire fleet is outfitted. Upon approval of an RRP request, the warfighter can generally expect the employment of systems within 60 days.[1] The actual amount of time required to complete the RRP depends on several factors: the complexity of the system, its level of maturity, and the availability of hardware.

The RRP begins when "HQ USAF, Major Commands (MAJCOMS) or warfighting Combatant Commanders issue the urgent, time-sensitive Combat Mission Need Statement (C-MNS)."[2] The C-MNS is the heart of the rapid response process. The C-MNS goes through a validation process to ensure a non-materiel solution does not exist before the Air Force Chief of Staff (CSAF) ultimately certifies the document. Once the CSAF certifies the C-MNS, it is

processed through a series of committees and councils that are led by operations and acquisition experts at the level of Colonel through Major General, and/or civilian equivalents. The processing of the C-MNS consists of conducting a feasibility assessment, developing approaches for solutions, preparing an acquisition strategy, determining who will be responsible for developing the system, identifying funding, and ultimately issuing the program management directive (PMD) to the acquisition organization responsible for development. From the time the C-MNS is first written to issuance of the PMD is no longer than 19 working days. Note that the RRP does not replace normal acquisition procedures, it simply speeds them up.[3]

The acquisition community is involved in the entire RRP process; however, they become the major players once the PMD is issued. The PMD is the official Air Force document that provides the acquisition community direction for the execution of funds to acquire systems. The PMD carefully lays out who is responsible for various aspects of the program from beginning to end, along with specifics regarding what the acquisition community should actually be acquiring. It is important to keep in mind that while the PMD is a very important document, it is derived from the C-MNS. Therefore, the PMD can only be as good as the C-MNS.

The required format and procedures for writing the C-MNS are found in AFI 10-601, *Mission Needs and Operational Requirements Guidance and Procedures*. Attachment 8 of AFI 10-601 describes the required format of the C-MNS, which consists of 6 primary paragraphs: General Description, Mission and Threat Analysis, Non-Materiel Alternatives, Potential Materiel Alternatives, Constraints, and Funding. These paragraphs are used to communicate critical information such as the deficiency requiring correction, non-materiel alternatives considered but found unacceptable, potential materiel solutions, constraints that could affect the solution to the deficiency, and the source of the funding. A look at the specific descriptions assigned to each

paragraph in AFI 10-601 will make one believe that the solution to the capability deficiency is not known when the C-MNS is written; however, experience tells a different story.

More often than not, the materiel solution has been researched and decided upon before the C-MNS is written. One Air Force officer in AF/XOR who was responsible for processing C-MNS stated that when he received a C-MNS, he often felt like a contractor had written the C-MNS as opposed to the warfighter who required the solution. This should not be a surprise, as it is common practice in the Air Force to have contractors write requirements. As long as no laws are broken, this in itself is not necessarily a bad practice. Integration of the ideas and solutions from warfighters, industry, and the acquisition community is a critical part of developing a successful solution. The earlier this integration occurs, the better—most of the time. However, as will be discussed later in the paper, it is important that a particular solution to the C-MNS not be adopted until sufficient analysis has occurred and various options have been adequately studied. If a solution is adopted too early, it may stifle other innovative ideas that may eventually provide an even better solution.

Immature Systems

As mentioned in the previous section, materiel solutions to C-MNS requirements are often the result of systems that have been in development for some time, ones that had previously been developed but shelved, or systems that are completely new and developed solely because of the C-MNS. In any case, the Air Force often fields these systems as immature systems, but what exactly is an immature system? For the purposes of this paper, an immature system is one that has not yet completed the prescribed operational testing, has not entered full rate production, and has not attained initial operational capability. The system may be anywhere along the acquisition development cycle including concept and technology development, system

development and demonstration, or in the early stages of production and deployment. In the case of advanced concept technology demonstrations (ACTDs) such as Predator, the systems may not have even entered the formal acquisition cycle. Regardless of the particulars of a given situation, an immature system is one that is less than fully developed.

Beginning with Operation Desert Storm, immature weapon systems have become increasingly critical to USAF operations, partly because the pace of new technology is moving so quickly. Joint STARS, for example, was one such system that provided the new capability of locating moving targets on the ground with an airborne sensor. This system was so immature, it required the engineers and scientists that designed the system to operate the equipment; the designers were the only ones who knew how. Nevertheless, the system was crucial to U.S. success in the Battle of Kfaji, and it has now become a mainstay to USAF operations.[4] The GBU-28 "Bunker Buster" is another example of an immature system employed during Desert Storm. Iraq had deeply-buried command and control bunkers that were difficult for the coalition to destroy. The answer to this capability gap was an innovative idea developed by the Air Force Research Laboratory Munitions Directorate located at Eglin AFB, Fl. In 26 days, engineers produced and delivered the new GBU-28, a 5000 lb laser-guided bomb using modified artillery tubes as the body of the weapon.[5]

While both Joint STARS and the Bunker Buster are examples of successful rapid response programs, there is a vast difference in their complexity. The Air Force designed, built, and employed the Bunker Buster in a matter of weeks; Joint STARS, however, was another story. Joint STARS had been in development for some time, but it had not gone through the requisite testing and preparation required to deem it operationally capable. Nevertheless, its utility had been demonstrated in an exercise before Desert Storm, and senior leaders recognized its potential

in spite of its immaturity. This was an important lesson for the USAF. Depending on the complexity of the system, the solution to an RRP may be dependent upon systems that are already in development. Herein lies the beauty and benefit of the ACTD program.

Advanced Concept Technology Demonstrations

In 1994, the DOD developed the advanced concept technology demonstration program as a way to exploit mature and maturing technologies to solve warfighter capability challenges. The ACTD program allows the warfighter an opportunity to understand and use a new system before the services decide whether to acquire the system.[6] Utilizing prototypes, the warfighter can field-test the system to determine whether it provides military utility. Based on the results, DOD can then make a decision regarding the transition of the ACTD to a formal acquisition program.[7] Generally, the systems involved in ACTDs utilize low-risk, mature technologies, and the demonstration programs last only 2-4 years. The focus of the ACTD is on the warfighter and incorporating their ideas into the acquisition of new systems. An important aspect of the ACTD is the leave-behind capability of the program. Should the warfighter determine that the prototype provides military utility and the DOD determines the system should be transitioned to a formal acquisition program, the prototypes used in the demonstration are then left for the warfighter to use in the operational environment until the actual production system arrives.[8] This practice has actually worked well; in some cases, prototype ACTD programs end up with hundreds of hours of actual combat time before the program even enters the acquisition cycle!

In July of 1995, one year after the inception of the ACTD program, the Air Force was looking for a system they could rapidly bring on line to provide persistent surveillance over Bosnia in support of Operation JOINT ENDEAVOR. They found their system—the Predator unmanned aerial vehicle—one of the first ACTD programs. The Predator ACTD prototype had

flown for the first time on 3 July 1994 and entered combat one year later in July of 1995. ACTDs were brand new and mostly unknown in the operational community. Nevertheless, the system performed very well, and the initial deployment of Predator was extended from 60 to 120 days.[9] Since that time, ACTDs have played a large role in providing solutions to C-MNS requirements and the rapid response process. "By 1999 some 20 percent of ACTD products were supporting Operational Allied Force in Kosovo. By 2001 thirty products were deployed for Operation Enduring Freedom in Afghanistan as well as Operation Noble Eagle at home."[10] Because new classes of ACTDs are selected each year, the focus of which ones are selected can be modified to meet the gaps of that time. For example, in response to the 11 Sept 2001 terrorist attacks, eleven of the fifteen ACTDs selected for 2002 are "directly focused on counter terrorism."[11]

No doubt, ACTDs have become a mainstay in our ability to rapidly fill capability gaps and deficiencies in the U.S. military's warfighting capability. The program provides a constant source of technology transition to capability that ultimately provides a store of updated capabilities for the warfighter to choose from when they determine an ACTD will solve a capability gap or deficiency. The other benefit of the ACTD program is it modifies the thinking of the acquisition professional. Because the goal of the program is to prove whether the system has military utility, it allows and even forces the acquisition professional to focus on the warfighter's needs. Additionally, with early input from the warfighter, the acquisition professional can implement changes and modifications into the program at a stage in the acquisition process when it is still relatively cheap in terms of time, money, and risk. At the same time, early involvement of the warfighter means that he can begin planning how the system will be utilized in the future and appropriately modify existing or create new concepts of

operation. Finally, an often overlooked benefit of ACTD programs is how these programs will shift the warfighter's paradigm from expecting perfect solutions, which take a long time and are usually very expensive, to accepting less-than perfect solutions, which can be done rapidly and much cheaper. The goal is to get usable capability to the warfighter as quickly as possible; this, in effect, is exactly what ACTDs provide to the warfighter.

Clearly there are processes in place to address warfighter needs during ongoing combat operations. The question one needs to ask, however, is whether RRP, immature systems, and ACTDs will be enough to fill the voids of the future. In an environment where technology is said to be doubling every 18 months, is the current system responsive enough, or are there changes that need to be made in order to ensure future capability gaps are solved efficiently and effectively? Finally, how will new initiatives such as effects-based operations and acquisition transformation influence the ability of RRP and immature systems to fill future capability gaps? These are the topics for the next chapter.

Notes

[1] Air Force Instruction (AFI) 63-114, Rapid Response Process, 15 December 2002, 1.

[2] Ibid., 2.

[3] Ibid., 1-6.

[4] Lambeth, Benjamin S. *The Transformation of American Air Power*. Cornell University Press, 2000, 122.

[5] Robert Sherman, "Guided Bomb Unit-28 (GBU-28) BLU-113 Penetrator," Federation of American Schientists (FAS) Military Analysis Network, on-line, Internet, 8 Mar 03, available from https://www.fas.org/man/dod-101/sys/smart/gbu-28.htm.

[6] "Advanced Concept Technology Demonstrations," *Deputy Under Secretary of Defense Advanced Systems & Concepts Website*, on-line, internet, 18 Feb 2003, available from http://www.acq.osd.mil/actd/index.htm.

[7] *Unmanned Aerial Vehicles: Progress of the Global Hawk Advanced Concept Technology Demonstration*, GAO Report NSIAD 00-78, (Washington D.C.: General Accounting Office), 4.

[8] Michael R. Thirtle, et al., *The Predator ACTD: A Case Study for Transition Planning to the Formal Acquisition Process,* (RAND, Corp, Santa Monica), 1997, 2.

[9] Ibid., 24.

Notes

[10] Sue C. Payton, "The ACTD Program," *Joint Force Quarterly*, Summer '02, 72.

[11] Sue C. Payton, "DoD Briefing of 2002 Advanced Concept Technology Demonstrations," *News Transcript*, on-line, internet, 5 Mar 2002, available from http://www.defenselink.mil.

Chapter 3

A Changing Environment

You will usually find that the enemy has three courses open to him, and of these he will adopt the fourth.

—Moltke, The Elder

Up to this point, the discussion regarding the use of immature systems to fill capability gaps has concentrated on the historical view. It began with a look at why capability gaps and deficiencies exist and then proceeded to examine the process used to fill the gaps and solve the deficiencies. The last chapter left off with a look at ACTDs and the increasingly important role they are playing in the Air Force's ability to solve challenges during combat operations. This chapter will shift focus and examine how some of the ongoing Air Force efforts will affect the acquisition professional's ability to solve future deficiencies and fill capability gaps for the next war. Air Force efforts such as Effects-Based Operations and Acquisition Transformation have the potential to dramatically enhance the acquisition professional's ability to support the warfighter during times of conflict. However, in order to achieve maximum benefit from these new initiatives, the Air Force must make some modifications to current practices.

Effects-Based Operations

In the last two years there has been a notable shift in thinking regarding military actions and how best to achieve desired results. In the past, Air Force planners have thought in terms of

which targets to destroy in order to achieve desired outcomes and ultimately obtain the military objective. Effects-based operations (EBO) expand the focus from targets and objectives to the "conditions and causal linkages through which actions lead to objectives."[1] This shift in thinking allows planners to move beyond the destruction of targets and examine what effect or effects must be achieved in order to obtain the objective. EBO results in several advantages, three of which are especially pertinent to this paper. The first is the inherent ability of EBO to compel the warfighter to thoroughly examine all of the potential effects of a specific action—direct and indirect, desirable and undesirable. Secondly, the examination of effects will highlight gaps and deficiencies in warfighter capabilities. Finally, EBO fosters an environment conducive to innovation.

One of the core functions of the EBO process is the determination of both direct and indirect effects. As seen in Figure 1, actions can have indirect as well as direct effects.[2] It may be that destroying a target is the best method available for achieving the desired effect; on the other hand, a non-lethal method such as information operations may also achieve the desired effect. While achieving effects through military action is not new, EBO puts increased emphasis on indirect effects, especially those that are undesirable. During Desert Storm, planners spent a significant amount of time determining the best method of turning off power in Baghdad. It would be incorrect to claim that planners did not consider the effects of this operation, as they were very concerned with the amount of damage they would impose on the electrical system. Knowing that electricity would be needed in the rebuilding phase following the war, they wanted to minimize the damage to the electrical system so electricity could be restored quickly and cheaply. As a result, the planners chose to take out the transformer yards as opposed to the generator yards.[3] The direct effects were achieved as planned; however, what they had not

considered were the secondary and tertiary effects of total loss of electricity in Baghdad. "Resultant subsystem failures included water and sewage treatment plants and hospitals that ultimately caused more devastating long-term effects on the Iraqi civilian population than anything the coalition intended."[4] The structured use of EBO could possibly have prevented these undesirable effects by highlighting the undesirable indirect effects and compelling the warfighter to find alternative solutions.

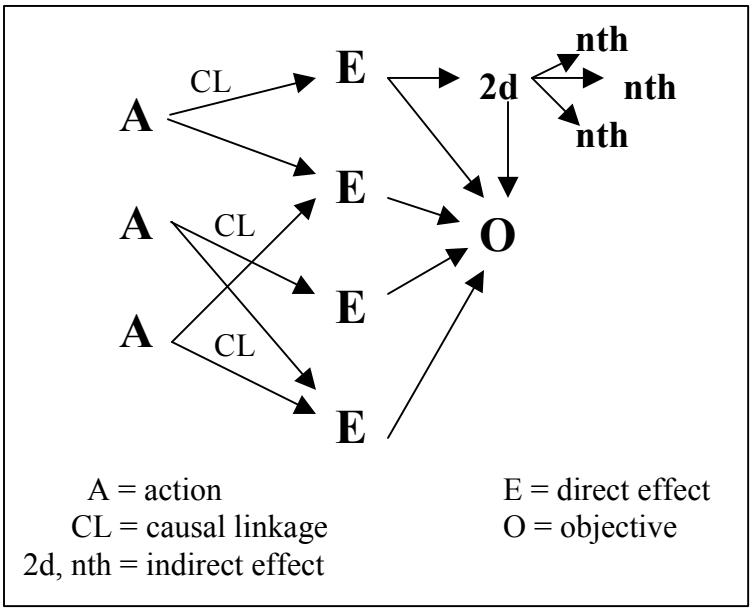

Figure 1. Relationships between Direct and Indirect Effects[5]

Using EBO, the warfighter's detailed analysis of direct and indirect effects will highlight capability gaps and deficiencies. Had the planners realized the effects on the population in Baghdad, they may have chosen a different course of action. The EBO analysis would have forced the planners to re-examine the objective and desired effects and allow planners to make a more educated decision as to whether or not turning off the electricity in Baghdad was the best course of action. They may have discovered there was another course of action that would result

in the same desired effect without the undesirable indirect effects. On the other hand, the planners may have looked at all potential courses of action and discovered what they were facing was, in fact, a gap in their capability. Once the capability gap is recognized, the rapid reaction process (RRP) could have been used to find an alternative materiel solution.

The final advantage EBO has over the more prescriptive targets and objectives planning process is its inherent ability to nurture innovation. As discussed previously, EBO forces the planner to focus on desired effects, both direct and indirect, along with why they believe the various actions will achieve those effects. This process allows the planner to automatically develop new concepts, or perhaps, integrate current concepts in a new way such that the employment of the weapon system(s) maximizes the desired effects while minimizing the undesirable ones. While the old system certainly allowed innovation, EBO forces the planners to think of a variety of actions to ensure they are maximizing desired effects and minimizing the undesirable ones. This builds an environment conducive to innovation because the EBO process urges planners to develop a variety of solutions and not just accept the first one that comes to mind.

The Rapid Response Process and Effects-based Operations

The previous chapter detailed the process the warfighter uses to fill capability gaps. Recall the warfighter essentially has three options: do nothing, develop a non-materiel solution such as a change in tactics or techniques, or develop a materiel solution. A materiel solution results in the employment of new systems through the rapid response process (RRP).

In the future, as the Air Force continues to embrace the structured EBO planning framework, immature systems will be used as materiel solutions to capability gaps discovered during the EBO process. Immature systems will do this in one or more of the following ways:

they may achieve an effect we currently cannot achieve; they may significantly enhance our ability to achieve an effect we can currently achieve—but in a more effective way; or they may add desirable or reduce undesirable indirect effects (nth order effects). For example, the Bunker Buster created a new effect in that it reduced the effectiveness of Iraq's highly protected C2 system; the Predator UAV achieved an effect more efficiently—persistent ISR, without reprogramming satellites; and the small-diameter bomb will minimize unwanted 2nd order effects by minimizing collateral damage. Regardless, once the gaps are recognized, the current RRP can be utilized to find a solution. However, if the warfighter wishes to gain the most benefit from EBO and RRP they must make two adjustments: modify the C-MNS to include desired effects and begin thinking of RRP as an integral function of the planning process, not just a separate and supporting program.

As mentioned in the previous chapter, the C-MNS is the heart of the RRP. However, the current format of the C-MNS is unable to take full advantage of EBO because the C-MNS does not include the desired effect the warfighter is attempting to achieve. Additionally, more often than not, the C-MNS specifies a solution that has already been researched and selected. If the solution is chosen too early, the C-MNS may stifle other innovative ideas that may eventually prove to be a better option. Therefore, the focus of the C-MNS should be shifted from a specific materiel solution to the desired effect the warfighter wishes to achieve.

This slight yet significant modification of the C-MNS will result in a fundamental difference that will dramatically affect what happens next. The new request will focus on the effect the warfighter is attempting to achieve rather than on the capability they wish to have. For example, instead of writing a C-MNS focusing on the development of Bunker Busters to destroy hardened underground Iraqi C2 facilities, the C-MNS will include the desired effects—reduced

effectiveness of Iraq's highly protected C2 network. This subtle shift in focus may result in solutions that differ from the more prescriptive system-based request. The new effects-based focus will allow the acquisition experts to begin developing potential solutions by thinking outside the box. In other words, EBO will foster more innovative solutions. When the warfighter explicitly states their requirement is to eliminate Iraqi highly protected command and control operations (desired effect), vice, the requirement for a bomb to eliminate Iraqi highly protected command and control operations (specific system), a fundamental shift in thinking and problem solving occurs. Instead of the acquisition community immediately turning to the Air Armament Center to begin building a GBU-28, they will send out a call for solutions from all Acquisition Enterprises. For example, ESC may determine they have a new information operations capability that could achieve the desired effect, or perhaps AFRL may determine their directed energy program could provide a solution. Regardless, the simple modification of adding the desired effect to the C-MNS may have a profound affect on the final solution.

It is important, however, that this additional look for alternative solutions not add time to the overall process of filling the capability gap. As mentioned in Chapter 2, the GBU-28 took 26 days to deliver to the warfighter. If an information operations solution would have taken double the time, even though it may have reduced undesirable effects, it still may not have been acceptable to the warfighter. Therefore, it is important to communicate to the warfighter the timeline for all alternative solutions, as time is likely to have an impact on which solution the warfighter accepts as most desirable.

The second adjustment required to gain the most out of RRP and EBO is the integration of the rapid response process with effects-based planning. Currently, RRP is a stand-alone process that is put into action whenever the warfighter recognizes a capability gap or deficiency exists.

The problem with this method is that the warfighter must recognize the gap or deficiency before the RRP process can begin. The warfighters are so busy planning and executing that they may not take the time to initiate a C-MNS. Worse yet, they may not even recognize the situation as a capability gap or deficiency. The situation may be viewed as merely another challenge that requires an alternative solution, but not important enough to go through the trouble of writing a C-MNS. The problem is, challenges can begin to add up to become something that eventually inhibits the warfighters' ability to achieve their objectives. The worst-case scenario is that the acquisition community has developed a product that could benefit the warfighter, but it is never fielded because the person with the need never gets together with the person with the solution.

To integrate RRP into the EBO planning process, there needs to be an increase in collaboration between the acquisition community and the warfighter. The acquisition community must be kept informed of the effects the warfighters have deemed necessary, the actions the warfighters plan to use to achieve those desired effects, and how well those actions are working. However, this increased communication cannot become a burden to the warfighter; the warfighter already has a big enough job in prosecuting the war. One solution is to insert acquisition professionals into the warfighting community, thus acting as a bridge between the warfighter and the acquisition community.

One obvious location to insert acquisition professionals into the warfighter community is the location where the bulk of EBO planning occurs—the Air Operations Center (AOC). Critics will argue that adding additional bodies to the already busting-at-the-seams AOC is a non-starter. The Air Force is working hard to reduce the footprint of the AOC, why would the Air Force add another body? The Air Force would not add additional bodies, but replace current ones with acquisition professionals. The best place to do that is in the strategy division. In the strategy

division, acquisition professionals can provide the warfighters with the maximum benefit by helping to determine the best actions for achieving desired effects across the theater, while working with the acquisition community to harness new capabilities otherwise unknown to the warfighters.

Acquisition professionals working in the AOC is not a new phenomenon. During the air campaigns over Bosnia, acquisition professionals deployed to the Combined Air Operations Center (CAOC) in Vicenza, Italy. Admittedly, these acquisition personnel were working at the CAOC in support of a very specific program, the rapid targeting system. Nevertheless, they provided a critical link between the warfighter and the acquisition community and were very important to the development of the sensor-to-shooter techniques utilized today for time critical targeting.[6] The recommendation in this paper, however, is not to temporarily deploy acquisition personnel to the AOC, but to make them permanent members of the AOC staff.

To make acquisition personnel permanent members of the AOC would require the growth and training of a cadre of personnel that have the right experience and skill set to do the job. The strategy division is the perfect location in the AOC, as this is the division responsible for the long-range planning and development of the JFACC's aerospace strategy. The acquisition person can look out over the long-term of the campaign and assess if the acquisition community should be looking for innovative methods to achieve future desired effects, while at the same time assessing how well current actions are progressing. They can be the link that ensures the JFACC is getting the support required from the acquisition community.

For acquisition professionals to be able to successfully operate in the strategy division of the AOC, while at the same time be the bridge back to the acquisition community, they would require specific training. The Air Force would have to carefully select specific individuals to fill

this role; however, over time a program could be developed to grow acquisition personnel with the right experience. In addition to being steeped in acquisition, acquisition professionals destined to work in the AOC would most likely require some experience in the operational world, and perhaps advanced training through the School of Advanced Air and Space Studies (SAASS) at Maxwell AFB. The Air Force could assure there are enough acquisition professionals available to fill these positions if particular attention is paid to which acquisition personnel are doing career-broadening tours into operations and by ensuring slots to SAASS are opened each year to a few select acquisition professionals.

The benefits of placing acquisition professionals in the AOC are numerous. The primary immediate benefit has already been discussed—the link back to the acquisition community to ensure all potential capabilities are being exploited. Another immediate benefit is that this acquisition person would replace a rated individual, thereby effectively putting one more person back into the cockpit. At the same time, it would utilize a person who otherwise would never deploy as part of the AEF structure. The long-term benefits relate to the experience gained by the acquisition professional when they return to acquisition. This person would be steeped in operations, be able to communicate more effectively with the warfighter, and have a better understanding of how best to support the warfighter in the future.

Acquisition Transformation

Over the past several years, the acquisition community has been transforming their processes in an attempt to provide the warfighter more timely, affordable capabilities. The SECAF has placed an increased emphasis on taking acceptable risk, reducing schedule slippages, collaboration between all parties, up-front systems engineering, training and career broadening, and evolutionary acquisition strategy. While all of these areas are important to providing

capability to the warfighter more rapidly, evolutionary acquisition strategy will undoubtedly enhance the acquisition professional's ability to support the warfighter in filling capability gaps during times of conflict in significant ways.

"Evolutionary acquisition is an acquisition strategy that rapidly acquires and sustains a supportable capability for the warfighter and incrementally inserts technology or additional capability to ultimately meet the warfighter's final requirements."[7] To execute evolutionary acquisition, the Air Force is moving toward a process called spiral development. "Spiral development processes work toward getting a 'core capability' into the warfighters' hands as quickly as possible, while continuing development during subsequent increments to add capability once the system is fielded."[8] Spiral development is fielding a capability that is less than the perfect solution. Once fielded, the system goes through a series of upgrades that eventually approaches something close to the perfect solution. During wartime, programs that are using the process of spiral development are critical to filling capability gaps. This is primarily because spiral development shortens the development cycle and, therefore, gets equipment to the warfighter sooner than would otherwise be expected. If the Air Force had developed the F/A-22 using spiral development, the warfighter may have had additional capability to use in Iraq. Instead, the strategy of producing the final solution the first time around resulted in a very long acquisition cycle. The F/A-22 will not be available, even as an immature system, for many years to come.

A perfect example of spiral development is the advanced concept technology development (ACTD) program. As discussed in detail in the previous chapter, ACTDs use mature technology to rapidly produced warfighting capability. The goal of the ACTD is to make the determination as to whether the program provides value to the warfighter within 2-3 years. If the program does

provide value and the warfighter chooses to fund the program, then the ACTD enters the acquisition cycle and is eventually produced and fielded. Due to the short nature of these programs and the fact that 10-15 new ACTDs are initiated each year, there tends to be several ACTDs in development at any given time. While many of the ACTDs do not develop into full programs, the development that is completed can be shelved, and perhaps, one day dusted off to fill a capability gap. As a result, ACTDs that may be thought of as unsuccessful because they did not go past the ACTD process can ultimately serve as gap-fillers in the future. For this reason, it is important that the DOD continue to fund the ACTD process, and senior leaders continue to encourage the acquisition community to put forward promising technologies as potential ACTD programs.

Something that has only been mentioned sparingly up to this point yet is an absolute requirement for filling capability gaps is innovation. It is through innovation that warfighters find solutions to many of their challenges. Whether employing a new immature system, or revising doctrine, tactics, or training, innovation is always present. To achieve a high level of military effectiveness, warfighters must be innovative. A study of military history will demonstrate that those who met great challenges during campaigns, yet were able to innovate, were often the victorious ones, while the vanquished were often the ones stuck using the same old tools and methods. It is therefore prudent for this examination of filling capability gaps with immature systems to address innovation—the topic of the next chapter.

Notes

[1] Col Edward C. Mann III, Lt Col Gary Endersby (Ret), and Thomas R. Searle, *Thinking Effects: Effects-Based Methology for Joint Operations,* CADRE Paper 15. (Maxwell Air Force Base, AL: Air University Press), Oct 2002, 2.

[2] Ibid., 52

Notes

[3] Ibid., 24
[4] Ibid., 25
[5] Ibid., 52
[6] Brad Purvis, DR-III, Technology Director UAV Battlelab, interviewed by author, 6 Mar 03.
[7] Air Force Policy Directive (AFPD) 63-1, *Capability Based Acquisition System*, Draft, 2003, 7.
[8] Ibid.

Chapter 4

Innovation

> *It must be considered that there is nothing more difficult to carry out, nor more doubtful of success, nor more dangerous to handle, than to initiate a new order of things; for the reformer has enemies in all those who profit by the old order, and only lukewarm defenders in all those who would profit by the new order; this lukewarmness arising partly from the incredulity of mankind who does not truly believe in anything new until they have had actual experience of it.*
>
> —Machiavelli, *The Prince*

An analysis of how the acquisition community rapidly employs new technology and immature systems to support the warfighters' needs during conflict would be incomplete without an examination of innovation. The important role innovation plays in the U.S. Air Force seems intuitively obvious; few would argue with the assertion that innovation has been key to past successes and most certainly will be key to future successes. General Jumper, a long-time advocate of innovation, recently stated, "Our future hinges upon our ability to capitalize on America's current technological dominance to achieve asymmetric advantage over our adversaries."[1] Additionally, in the recent refinement of the Air Force's Core Competencies, two of the three specifically mention the importance of innovation in their definition—technology-to-warfighting, and integrating operations.[2] However, just because the Air Force recognizes the importance of innovation does not mean it innovates as well as it could. This chapter will explore current innovation concepts and how they relate to rapidly producing combat capability for the warfighters. After examining the various definitions of innovation, the chapter will shift

focus to the sources of Air Force innovations and end with a discussion regarding changes the Air Force might make to best capitalize on those sources. While the following discussion focuses on how innovation enhances the acquisition professional's ability to fill capability gaps with immature systems during conflict, the concepts are also pertinent to innovating throughout all types of acquisition support to the warfighters.

Innovation – The Definition

The dictionary defines innovation as, "the act of introducing something new."[3] This broad definition is certainly useful as its allows one to see that innovation occurs across the full spectrum of operations and, therefore, is not limited to new weapon systems, tactics, or warfighting operations. To keep Air Force organizations moving in a forward direction, with continuous improvement, all forms of innovations are required. For example, a non-warfighting innovation such as the development of superior performance-report-writing software is a helpful innovation that assists in increasing the smooth flow of paperwork for normal day-to-day operations. Nevertheless, this analysis requires a more focused definition of military innovation, one that is useful for examining innovations that specifically result in new warfighting capability.

Stephen Peter Rosen, a well-known author on military innovation, relates innovation as something involving "a new way of war, with new ideas of how the components of the organization relate to each other and to the enemy, and new operational procedures conforming to those ideas."[4] He goes on to say that innovation includes changing critical tasks associated with war plans.[5] The problem with Rosen's definition, as aptly stated by Jeffrey Isaacson, et. al., is that "effective military modernization need not require inventing new ways to wage war."[6] As an example, Isaacson discusses how the North Vietnamese used old Maoist infantry tactics and executed them in a way that was very innovative, thus rendering the U.S. military relatively

ineffective. In sum, then, the dictionary definition is too broad—it considers all new things "innovations"; Rosen's definition is too narrow—it requires one to "invent new ways to wage war." As a result, Isaacson, et al., developed a definition that splits the middle: "the development of new warfighting concepts and/or new means of integrating technology."[7]

This definition of military innovation comes very close to hitting the mark. Its two independent, yet related parts (development of new warfighting concepts, and/or new means of integrating technology) are broad enough to include non-materiel as well as materiel solutions, yet narrow enough to exclude those innovations not directly associated with conflict. The definition, however, requires two slight modifications. First, to contemporize the definition, a simple substitution of the word "capability" for "concepts" is necessary. Second, the "and/or" in the middle of the definition creates a problem. The "and/or" means that the integration of technology alone is considered a military innovation, independent of producing new warfighting capability. Yet when discussing military innovations in the context of combat operations, producing new warfighting capability must be fundamental to the definition. Therefore, it is inappropriate to consider the integration of technology an innovation independent of producing new warfighting capability. Another word substitution such as "with or without," might help; however, the best way to handle this situation is to just drop the second half of the definition. This leaves the definition of military innovation as simply, "the development of new warfighting capability," a simple, yet elegant definition that captures the essence of the warfighters' requirements. The point is this: military innovation is about producing new warfighting capability, not producing new technology. Yes, a military innovation may include the use of new technology, but technology alone is not a military innovation.

Now that the definition of military innovation has been focused and refined, it is possible to complete a more in-depth analysis of the intricacies of military innovation. To begin with, it is useful to examine where innovations and ideas for innovations are developed. By understanding the various sources of innovation, the Air Force can ensure they are postured to obtain maximum benefit from the ideas of each of those sources.

The Sources of Innovation – the Theory

The sheer mass of literature regarding innovation, what it is, how to recognize it, who is best at it, why it is necessary, etc., is overwhelming. It is one of the hottest topics in business schools today, primarily because industry has recognized the relationship between market leaders and innovations. Eric von Hippel, a Professor at the Massachusetts Institute of Technology who specializes in research related to innovation, spent twelve years researching one small, yet very significant area related to innovation—the sources of innovation. While his data and findings focus on for-profit industry, they are also pertinent to military innovation and have the potential to enhance how the Air Force capitalizes on all of its sources of innovation to produce enhanced warfighting capability.

Conventional wisdom holds that product manufacturers are typically the developers of innovations. It is common to view the innovation process as manufacturers seeking out and analyzing user needs, then using their research and development (R&D) departments to develop new products to meet those needs. Contrary to conventional wisdom, through an examination of over 250 innovations Von Hippel discovered that, "the sources of innovation vary greatly. In some fields…users develop most innovations. In others, suppliers of innovation-related components and materials are the typical sources of innovation. In still other fields, conventional wisdom holds and product manufacturers are indeed the typical innovators."[8] For example, Von

Hippel's research uncovered the fact that the preponderance of innovations in scientific instruments occurs with the user vice the manufacturer (77% versus 23%), while the opposite is true for tractor shovels (6% versus 94%). Overall, five of the nine categories of innovation he examined led to the conclusion that the user was, in fact, the developer of the preponderance of innovations.[9] While these data and analyses are interesting, in and of themselves they are of limited value. The real value comes in the insight Von Hippel gained in being able to predict the source of innovation.

To predict the source of innovation, Von Hippel tested his hypothesis that "innovations will be developed by those who expect a return they find attractive. But the [results of the] data show that innovations of a specific type are typically developed by firms that expect the *most* attractive return" (emphasis in original).[10] In other words, while various sources of innovation may find a particular innovation attractive, some will find it more attractive than others, and therefore, have more incentive to innovate. Von Hippel then concludes that by understanding where innovations of a specific type typically occur, one can focus his or her efforts on learning the needs and requirements of those sources, thereby, creating opportunities to develop new products. An example may help illustrate this point.

Consider a company that uses oscilloscopes in their development of new widgets. During the development of a new widget, they determine they need a new oscilloscope capability. They comb the market and discover that no existing oscilloscope manufacturers produce the specific oscilloscope capability they require. Unfortunately, without this new oscilloscope capability, the widget manufacturer is unable to continue with the development and production of its new widgets. With nowhere else to turn, the widget manufacturer has a choice: live without the

required capability, develop the new oscilloscope capability themselves, or convince someone else to develop it for them.

According to Von Hippel's theory, if the widget manufacturer sees the development of widgets as resulting in an attractive enough return, they will innovate. Sure, they must have the technical expertise to handle this innovation, and in some cases, the user will not. Nevertheless, the oscilloscope manufacturer could have capitalized on this innovation if they would have recognized a market need for that particular oscilloscope capability. Perhaps, the oscilloscope manufacturer could have even sold similar capabilities to other manufacturers. However, they missed this innovation because they did not recognize an attractive return that would drive them to innovate.

On the surface, it may seem that this example is simply supporting the idea of paying close attention to one's customers, which is certainly not a new concept. Business experts have been preaching this for many years, and the most successful companies have heeded the advice. However, when Von Hippel dug deeper into this concept of paying close attention to one's users (customers), he discovered that not all users are created equal.

Since the 1940s, researchers have been exploring user's ability to generate innovations (sometimes called novel products). Von Hippel's research validated and added to the body of knowledge that demonstrates that many users are, in fact, poor innovators. Von Hippel summarizes this research as follows:

> The notion that familiarity with existing product attributes and uses interferes with an individual's ability to conceive of novel attributes and uses is strongly supported by research into problem solving. We see that experimental subjects familiar with a complicated problem-solving strategy are unlikely to devise a simpler one when this is appropriate. Also…we see that subjects who use an object or see it used in a familiar way are strongly blocked from using that object in a novel way. Furthermore, the more recently objects or problem-solving strategies have been used in a familiar way, the more difficult subjects find it to

> employ them in a novel way. Finally, we see that the same effect is displayed in the real world, where the success of a research group in solving a new problem is shown to depend on whether solutions it has used in the past will fit that new problem. These studies thus suggest that typical users of existing products…are poorly situated with regard to the difficult problem-solving tasks associated with assessing unfamiliar product or process needs.[11]

In summary, this statement says that not all users have equal ability to innovate. In fact, the research shows that "typical users" are unable to innovate. Therefore, attempts to engage users with the goal to learn about their requirements and gain from their ideas may be futile. This, of course, sets up an interesting contradiction to Von Hippel's earlier analysis that clearly demonstrates the user is the innovator more than half the time. How can that be? The answer is that while many users are unable to innovate, a select few are different; they are what Von Hippel terms "lead users."

Lead users are those users that exhibit two characteristics: they "face needs that will be general in the marketplace, but they face them months or years before the bulk of the marketplace encounters them; and, lead users are positioned to benefit significantly by obtaining a solution to those needs."[12] Once the lead users of a given product category are determined, efforts to engage users can be focused on those select few lead users, because it is here that one gains the most regarding future needs and requirements.

The Sources of Innovation – Application to the Air Force

As defined earlier, innovation is the development of new warfighting capability. The sources of innovation in the Air Force are at least as widespread as industry, perhaps even more so. There are four primary sources of innovation related to the Air Force: the warfighters, industry, the acquisition community, and the battlelabs.[13] Using Von Hippel's framework of distinguishing the sources of innovation between users and non-users (manufacturers and

suppliers), Air Force sources of innovation can be distinguished similarly: the warfighters represent the users and everybody else represent the non-users (industry, the acquisition community, and the battlelabs). Some might argue that the battlelabs are also users, as their workforce primarily consists of operators who have used, or will be using, the systems they are trying to innovate. However, the battlelabs are not warfighting units per se; therefore, even though their experience, ideas, and thinking may be closer to the warfighters than acquisition or industry, they still do not have the same incentives to innovate as the warfighters. This distinction will become even more apparent later during the discussion of lead warfighters.

Recall that one of Von Hippel's major findings was that the source of innovation tended to be the organization that expected to find the most attractive return. Relating this to the Air Force, there is no question which source should expect to find the most attractive return—the warfighters. The warfighters are the ones that have their lives at stake, and when one discusses warfighting capability, there is no more attractive return than remaining alive. Therefore, just as the users in Von Hippel's research tended to be the source of the majority of the innovations, one would expect the Air Force warfighters to be the source of the majority of Air Force innovations. There is, however, one significant difference between warfighters and the users Von Hippel examined.

In Von Hippel's research of for-profit industry, the user had the ability to develop and produce innovations themselves. In the example used previously, the widget manufacture had the ability to design and build an oscilloscope when one with the required capability was unavailable. If they did not have the capability in-house, they could purchase that capability either by hiring the expertise or subcontracting to another source. In the Air Force, however, warfighters generally do not have an indigenous capability to acquire their own systems (AFSOC

and AFSPC are exceptions, of course). Nevertheless, just because the warfighters cannot do the actual engineering, development, and production does not mean they are unable to innovate. Through their ideas and concepts, the warfighters are just as valid a source of innovation as the users are in commercial industry. For example, it was the warfighter that generated the idea of putting lasers and Hellfire missiles on Predator, it was the warfighter that generated the idea of the Bunker Buster, and the warfighter was the one that pushed Joint Stars into service during Desert Storm.

Therefore, given the fact that a.) the warfighters have the most incentive to innovate, and b.) research suggests those with the most incentive to innovate will have the preponderance of ideas for innovation, it should logically follow that those who are responsible for the actual engineering and development of systems should look to the warfighters for their ideas and concepts. Obviously, this is not a big surprise. The Air Force long ago recognized this and even designed its requirements generating process around warfighter input. However, Von Hippel also discovered that not all users have equal ability to innovate. His research demonstrated that it was futile to engage the "typical user." He discovered the "lead user" was the only user that exhibited the characteristics required for user innovation. In industry, discovering one's "lead user" is a challenge; in the Air Force, it is relatively easy.

The distinguishing characteristic between "warfighters" and "lead warfighters" is combat operations. Those warfighters engaged in combat operations are the ones with the most incentive to innovate. They are the users faced with filling capability gaps, the ones most needing to improvise, and the ones that require the latest innovations. They are also the ones that non-users, those charged with acquiring innovative warfighting capabilities, should be focusing their efforts on to gather ideas on innovations.

Currently, the rapid reaction process, through the use of C-MNS, is the best source for ideas and innovations from the lead warfighters during combat operations. For this reason, the previous recommendations for modification of the C-MNS included adding the desired effects but did not include the removal of the warfighters' ideas for solutions. Since the warfighters are the ones that have the most at stake, they are also likely to be the source of the innovation that will provide the best solution. However, it must be kept in mind that the warfighters may not be aware of all the various options or capabilities in development. For this reason, its important to add the desired effects to the C-MNS as recommended earlier.

Besides the rapid response process, few formal processes allow non-users to capitalize on the ideas and innovations of the lead warfighters. After-action reports are a good source of recommendations for innovations, and in recent operations, the Air Force has become more proactive in getting those reports written as quickly as possible. In the case of Operations Enduring Freedom and Noble Eagle, the Air Force actually had the after-action team writing their reports while the operation was still on going. This undoubtedly helped in preparation for Operation Iraqi Freedom. However, there may be other opportunities to ensure the warfighters' ideas for innovation are being heard in order to gain the maximum support from the non-users.

Capitalizing on the Lead Warfighters as a Source of Innovation

The single most important recommendation of this research paper, and the common thread of all the recommendations, is to increase the level of collaboration between the lead warfighters and those that support them with new warfighting capabilities. The only sure method of tapping into the lead warfighters' ideas and innovations is through increased communication. There are numerous methods for communication: the C-MNS is one, the requirements process is one,

after-action reports are another. Without a doubt, however, the most effective forum is face-to-face discussions.

One of the previous recommendations relating to integrating the rapid response process with the effects-based operations planning process was to include acquisition professionals in the strategy division of the Air Operations Center (AOC). Not only will this increase communications between the acquisition community and the warfighters, but also in light of the discussion in this chapter, it will increase the communications between the lead warfighters and those supporting them. However, to maximize the usefulness of the lead warfighters' ideas, there must be more integration than just at the AOC.

The Air Expeditionary Wing (AEW) is where "the rubber meets the road," and it is another place to consider integrating acquisition professionals with the lead warfighters. Each time an AEW stands-up, a contingent of acquisition personnel who specialize in the deployed weapon systems would be integrated as part of that AEW. This group of acquisition professionals would be responsible for liaising between the lead warfighters and the acquisition community in addition to collecting and disseminating the lead warfighters' ideas and innovations. This contingent of AEW acquisition professionals can be specifically looking for capability gaps, working with others to determine possible solutions, and communicating with the labs and industry for innovative solutions.

Some will argue that an acquisition person deployed with an AEW will not be value added, that there is no room for acquisition personnel, and that the AEW Commander has enough to worry about without having to deal another set of personnel. No doubt, the acquisition professional is not needed to generate sorties. However, how much time are the lead warfighters spending collecting and documenting their ideas and innovations, how much time do the lead

warfighters spend looking for capability gaps, and how much time do the lead warfighters spend thinking about how their current experience can influence the next-generation system? The answer is, probably not much. This author's personal experience is that the lead warfighters have enough on their plate just prosecuting the war; worrying about these extra items is simply not possible.

In today's modern war, where the lead warfighters have recognized the benefits of having media embedded in the U.S. military's combat units, it seems odd that the same has not occurred with blue suit acquisition professionals. While there are many reasons for the Air Force having active duty acquisition professionals, the most compelling is to act as the link between the warfighters and industry. Yet, if the level of communications between the lead warfighters and the acquisition professionals are only via the requirements process, C-MNS, and occasional interactions, it is no surprise the warfighters are not always happy with the systems acquired.

Recognizing this recommendation of deploying acquisition professionals with AEWs may pose a barrier that cannot be overcome; there is a second option. The second option is to capture the ideas and innovations of the warfighters immediately after they return from their operation. A contingent of acquisition professionals representing the deployed systems could travel to the home bases of those recently reconstituted and attempt to capture the lessons learned. The benefit to this solution is that the contingent of acquisition professionals could be much larger and include experts from industry and other non-combatant organizations. This approach would also reduce added stress on the deployment system by not increasing the number of Air Force personnel deploying. Finally, collaborating with units during reconstitution would alleviate any concern that embedding the acquisition personnel in the AEW would interfere with those attempting to prosecute the operation.

Perhaps the best solution is a combination of the two options. Integrate a very small number of acquisition professionals with each AEW to provide the AEW/CC with focused reach back capability, while also taking advantage of reconstitution by sending systems experts to the home stations of the lead warfighters immediately after returning from combat operations. By capturing the lead warfighters ideas and innovations during combat operations and immediately following operations, the Air Force will more effectively utilize the lead warfighters as an important source of innovation. One category of Air Force programs, the advanced technology concept demonstrations (ACTDs), already utilizes several aspects of this recommendation, and it provides a model for how to maximize the benefits of the lead warfighters' ideas and innovations.

Recall that ACTDs rapidly convert mature technology into prototypes that are then field-tested by the warfighters to determine military utility. Based on the results, DOD can then make a decision regarding the transition of the ACTD to a formal acquisition program. By accomplishing the field-testing in combat operations, the ACTDs are being "wrung out" by the lead warfighters, and the acquirers are able to capitalize on those lead warfighters ideas and innovations for improvement. This is not to say these systems will not require further formal testing, as combat will often not push the systems to all corners of the envelope. However, one of the reasons it is possible to capitalize on the lead warfighers' ideas is that the ACTD, by design, requires a high level of collaboration between the acquisition professionals and the lead warfighters.

The immaturity of ACTDs creates a situation that can be both frustrating and fruitful at the same time. It can be frustrating to the lead warfighters because the system is atypical. Among other things, technical orders (TOs) do not exist, equipment is not standardized, spare parts do

not have national stock numbers (NSNs), and training is ad hoc. The systems are so immature that the lead warfighters have no choice but to count on acquisition professionals and contractors to operate and maintain the equipment. Together, these characteristics can add up to frustration for the lead warfighters, however, they also add up to a level of collaboration seldom seen during the development of most weapon systems.

The benefits of the close collaboration between the acquisition professionals and the lead warfighters on an ACTD far outweigh the negatives of working with an atypical system. Employing these systems in combat provides critical feedback from the lead warfighters, not in a written report or via a briefing or teleconference, but in everyday face-to-face discussions between the lead warfighters and acquisition professionals. This level of collaboration and capture of lead warfighters' ideas and innovations is something that cannot be achieved through normal test and evaluation. For this reason, it is important that the Air Force not shy away from employing ACTDs in combat operations, and it should examine how other immature non-ACTD programs might be used during combat operations.

Finally, the last area to consider in determining how to best tap into the ideas and innovations of the lead warfighters is through the Air Force Battlelabs. The Air Force created the battlelabs in 1977 to rapidly identify and demonstrate the military utility of innovative near-term concepts for the warfighter. These innovative near-term concepts can be in the form of materiel or non-materiel solutions. The battlelabs are not part of the acquisition process, however, they work in conjunction with the acquisition community to provide the warfighters with innovative solutions. While the battlelabs are staffed with a small cadre of 15-25 personnel consisting mainly of operators, they do have one liaison from Air Force Materiel Command who is usually an Air Force Research Lab (AFRL) representative.

While researching the Air Force Battlelabs, it was readily apparent that they have been providing benefit to the lead warfighters since their inception. With regard to filling capability gaps, the battlelabs have done an outstanding job. For example, in 1998 the UAV Battlelab developed the capability to send live, real-time video from the Predator UAV to another airborne platform using an existing C-Band antenna. At the time, this capability was not recognized as something that would be beneficial to the warfighter. The system was not funded and eventually was shelved. Four years later, during Operation Enduring Freedom, the AC-130 Gunship operators experienced difficulties in finding targets that were relayed to them via voice communications from the Predator UAV. This deficiency was noted, and the UAV Battlelab was asked if it was possible to transmit the actual live video that the Predator operator was seeing directly to the Gunship. The UAV Battlelab dusted off the work that had been completed in 1998, acquired the equipment, and began installing it on the Gunship immediately. This capability has now become standard operating procedure for integrated operations between the Predator and the AC-130 Gunship.[14]

However, when examining the process by which the battlelabs and the acquisition community collaborate, it was readily apparent that neither the acquisition community nor the battlelabs are maximizing use of each other's expertise. When asked whether AFMC was taking maximum advantage of the innovations the battlelabs are developing, a senior AFMC leader stated, "no." When asked whether the battlelabs were taking maximum advantage of innovations from AFMC, battlelab representatives also stated, "no." Both the battlelabs and AFMC admit that each have certain advantages: the battlelabs have operators who are experts in operations, and AFMC has engineers, scientists, and program managers who are experts in acquiring

weapon systems and working with industry. The challenge is bringing the various expertises together so that the lead warfighters gain the maximum benefit.

One solution may be to put the two organizations under the same command, located at the same physical location. Since the battlelabs are very small compared to the acquisition community, it would make sense to move all of the battlelabs organizationally to AFMC. The logical location to place the battlelabs in AFMC would be at the Product Centers. However, there are more battlelabs than Product Centers, so the battlelabs would have to be divided and then distributed between the three Product Centers in AFMC. The only exception would be the Space Battlelab, which would move intact to AFSPC's Space and Missile Center. Each Product Center would then have a battlelab, or perhaps, innovation lab, that would perform similar roles as currently performed; however, they would presumably accomplish their mission with a higher level of collaboration with the acquisition community than is currently achieved. The key to this plan is to ensure that the rated positions and people of the current battlelabs transfer to the Product Centers. Without those experienced operators, the same level of innovation would not be achieved.

The downside to this solution is the affect it may have on the relationship between the battlelabs and the lead warfighters. There is clearly a cultural difference between the acquisition community and the lead warfighters. The battlelabs seem to be able to bridge that cultural gap, primarily due to the warfighting background of their personnel and the fact that they organizationally report to warfighting commands. The danger to moving the battlelabs to AFMC is that close relationship between the battlelabs and the lead warfighters could be lost. Once the battlelabs lose their close relationship to the lead warfighters, they will be in the same boat as

most of the current acquisition community. Therefore, another solution must be examined that can bring the expertise of the acquisition community and the battlelabs together.

The second option may be to maintain the battlelabs in their current location under their current command structure, but increase their level of manning by adding more acquisition professionals. Currently, each battlelab has one position for an acquisition professional, although not all of the battlelabs actually have someone occupying that position. The benefits of increasing the number of acquisition professionals are numerous.

What the acquisition professional brings to the battlelabs is the knowledge required to bridge the gap between the warfighters and industry. The acquisition professional has spent a career discovering how to motivate industry, learning how to recognize when contractors are taking advantage of the situation, and understanding the intricacies of navigating the bureaucracy associated with money, and contracts. Furthermore, the acquisition professional understands how to leverage the resources associated with the Air Force Research Laboratories, the Product Centers, and the Air Logistics Centers. It is hard to believe the battlelabs could not benefit immensely from having this type of expertise in-house, in addition to the associated professional development benefits of acquisition professionals learning from warfighters and vice-versa.

In sum, by increasing the collaboration between the lead warfighters and the acquisition professionals during and after combat operations, combined with continued use of ACTDs and the restructuring of the Air Force Battlelabs; the Air Force should be well on its way to capitalizing on the lead warfighters as one of its most important sources of innovation.

Notes

[1] General John P. Jumper, "Air Force Leadership," *Technology Horizons Magazine*, June 2002, on-line, Internet, 15 Mar 2003, available from http://www.afrlhorizons.com/leadership.html

[2] Dr. James G Roche, Secretary of the Air Force, *The Secretary's Vector*, 14 Jan 2003.

[3] *The American Heritage Dictionary of the English Language*, 4th ed., s.v. "innovation."

[4] Stephen Peter Rosen, "New Ways of War: Understanding Military Innovation," *International Security*, Summer 1988, 134.

[5] Ibid., 134

[6] Jeffrey A. Isaacson, Christopher Layne, John Arquilla, *Predicting Military Innovation*, RAND Document DB-242-A (Santa Monica California, 1999), 7.

[7] Ibid., 8.

[8] Eric von Hippel, *The Sources of Innovation*, (New York: Oxford University Press, 1988), 3.

[9] Ibid., 4.

[10] Ibid., 8.

[11] Ibid., 102.

[12] Ibid., 107

[13] The term "acquisition community" used in this paper is inclusive of the following: those who acquire systems, the research laboratories, and the logistics centers. The levels of innovation that occur within and among these three areas vary dramatically. The Air Force Research Laboratories are the primary source of new-cutting-edge innovations within AFMC, and the Air Force, while the logistics centers' innovations tend more along the lines of enhancing the performance, sustainment, maintainability, and reliability of systems. Those that acquire systems are also capable of innovating, and often direct industry in a manner that leads to new, innovative products.

[14] Brad Purvis, UAV Battlelab, interviewed by author, 16 Mar 03.

Chapter 5

Conclusions and Recommendations

When the Acquisition Enterprise, consisting of the Warfighter, Acquisition, Test, and the Sustainment community, starts working together a better product is produced.

—Dr. Marvin Sambur, Assistant Secretary
of the Air Force (Acquisition)

This paper set out to explore the methods used by the Air Force acquisition community to fill capability gaps and solve deficiencies during combat operations. Warfighters should expect to discover deficiencies or gaps in their capabilities during times of conflict, as no amount of preparation will cover all armed conflict situations. In some situations, the gaps will not be showstoppers, and the warfighters may press ahead while recognizing a gap exists. At other times, a simple modification of tactics or techniques will rectify the problem. Some situations, however, will require a materiel solution—a solution that goes beyond tactics and techniques and requires a new system or capability. When a materiel solution is required to fill a capability gap, the Air Force has in place a process called the rapid response process (RRP). Using the RRP, the Air Force is able to quickly develop and employ new warfighting capability, often with new technology and immature systems. While immature systems are, by definition, less than fully developed and often have not completed testing, they nevertheless have become a mainstay in how the Air Force solves many of its combat challenges.

Effects-Based Operations

Effects-based operations (EBO) shifts the war planner's thinking from the destruction of targets to the effect or effects required to achieve the desired objective. Using EBO, planners focus on all of the potential effects of a specific action—direct and indirect, desirable and undesirable. This careful examination of effects will highlight gaps and deficiencies in the warfighter's capabilities along with creating an environment conducive to innovation. Once the capability gaps or deficiencies are highlighted, warfighters can use the RRP to fill those gaps. However, if the Air Force wishes to take full advantage of EBO, two changes are required: RRP must become integral to EBO operations at the AOC, and the C-MNS must be modified to include not only recommended solutions, but also the desired effects.

To fully integrate RRP into the EBO planning process, planners must continuously review the desired effects in conjunction with the capability available for achieving those effects. This requires a significant increase in collaboration between the acquisition community and the warfighters; consequently, this paper recommends the Air Force permanently assign acquisition professionals to the strategy division in the AOC. These personnel will provide the JFACC instant knowledge of cutting-edge capabilities, provide a critical link for the JFACC back to the acquisition community, and put rated personnel back into the cockpit by replacing them with non-rated personnel. An associated benefit of this recommendation is that it fills AEF positions with personnel who would not normally be part of the AEF structure, thereby increasing the utilization rate of Air Force personnel supporting the AEF. Finally, the last benefit relates to the long-term advantages of having senior acquisition professionals who have AOC operations experience.

Another change that will help integrate RRP with EBO is a small but necessary modification to the current format of the C-MNS. Whereas the current format focuses on the materiel solution recommended by the warfighters, the new format will focus on the desired effects. As discussed in Chapter 2, the C-MNS is usually written to include the specific materiel solution the warfighters desire. This paper recommends that the C-MNS be modified to also include the desired effects; this will allow the acquisition community the opportunity to examine a variety of solutions instead of zeroing in on one solution from the beginning. Ultimately, this change will help to foster innovation and allow the acquisition community to examine a variety of options for solutions to the C-MNS. This slight, yet significant modification will result in a fundamental difference in how C-MNS solutions are derived and may result in solutions that are more effective.

Lead Warfighters as a Source of Innovation

Military innovation, defined as the development of new warfighting capabilities, has been, and will continue to be critical to filling capability gaps during combat operations. Research has demonstrated that while the sources of innovation tend to vary, it is possible to predict which source will innovate based upon who expects the most attractive return. Related to the Air Force, the warfighters would expect the most attractive return from an innovation, and therefore, those that provide warfighting support should turn to the warfighters for their ideas and innovations. However, research also demonstrated that all warfighters are not created equal, that the "lead warfighters"—those engaged in combat operations—have the "most" incentive to innovate, and therefore, those developing warfighting capability need to ensure they are capitalizing on the "lead warfighters'" ideas and innovations.

Note that there is a purposeful distinction here between warfighters and lead warfighters. Research clearly demonstrates that the "typical user" is, in fact, unable to innovate due to pre-conceived ideas as to how things should operate. It is only the lead users, or in the case of the Air Force, the lead warfighters, that have the incentive to reach beyond the familiar. This does not mean that innovation cannot occur from other sources, it just means that the best source of innovation is the lead warfighters. To capitalize on the lead warfighters as a primary source of innovation, the following recommendations are made: first, a small number of acquisition professionals should be embedded into each AEW; second, a team of acquisition system's experts should be sent to the lead warfighters' home station following combat operations; and third, the Air Force Battlelabs should include more acquisition professionals.

Embedding acquisition professionals into the AEW will provide the AEW/CC with a trained set of eyes and ears for everything related to acquisition support of the deployed systems. The embedded acquisition professionals would be responsible for liaising between the lead warfighters, the acquisition community, and industry; looking for capability gaps and solutions to those gaps; and collecting and disseminating the lead warfighters' ideas and innovations. These acquisition warriors would go through specific training, occupy a mobility position, have experience related to the assets employed, and be cleared on any classified programs associated with the platforms on which they specialize. While these personnel could certainly be used for logistics and sustainment support, they would pay particular attention to the lead warfighters and their concerns, ideas, frustrations, and ideas for innovations. Just as integrating acquisition professionals into the AOC would result in short-term benefits of increased collaboration and long-term benefits of enhanced professional development, so to will embedding acquisition professions in the AEW result in similar short- and long-term benefits.

While it would only be possible to embed a small number of acquisition professionals into each AEW, a second method of capturing the lead warfighters ideas and innovations is to send a much larger contingent of system's experts to the lead warfighters' home station immediately following combat operations. This would allow those experts who did not have the advantage of being with the lead warfighters during combat operations an opportunity to discuss the lead warfighters ideas and innovations face-to-face. As with the first recommendation, collaboration between the two communities would be enhanced and the acquisition community would have an increased opportunity to capture lead warfighters' ideas and innovations.

The final area regarding the lead warfighters as a primary source of innovation relates to the Air Force battlelabs. While the battlelabs are not warfighting units per se, and therefore cannot be considered lead warfighters, they are staffed with personnel who have been lead warfighters in the past and are a great source of information and innovation. The battlelabs have clearly proven they are able to provided innovative solutions to warfighter needs. The challenge is to capture the expertise of the battlelabs and combine it with that of the acquisition community so that the lead warfighters end up with the best solutions.

Chapter 4 examined two possible solutions to this challenge: move the battlelabs organizationally to the acquisition community, and increase the robustness of the current battlelabs with increased acquisition personnel. As noted in the discussion, the first option risked losing the close relationship the Battlelabs currently have with the lead warfighters, and therefore, negated the main benefit of the current configuration of the battlelabs. For this reason, the second option was selected as the best solution.

An increased presence of acquisition personnel in the battlelabs will assist the battlelabs in providing the warfighters will innovative solutions to their challenges. The primary asset the

acquisition professional brings to the battlelabs is the knowledge required to bridge the gap between the warfighters and industry. The acquisition professional has spent a career discovering how to motivate industry, learning how to recognize when contractors are taking advantage of the situation, and understanding the intricacies of navigating the bureaucracy associated with money, and contracts. They will bring this knowledge to the battlelabs, thus making the battlelabs more effective. Furthermore, the acquisition professional understands how to leverage the resources associated with the Air Force Research Laboratories, the Product Centers, and the Air Logistics Centers, once again benefiting the overall mission of the battlelabs. Together, increased collaboration will enhance the battlelabs' ability to capture and capitalize on the lead warfighters ideas and innovations.

Acquisition Transformation

Spiral development is the aspect of acquisition transformation that will have a dramatic affect on the ability of the acquisition community to better fill capability gaps. Spiral development will help speed up the acquisition process, and therefore, provide more options for the warfighters when capability gaps are determined. One particular type of spiral development, the advanced concept technology demonstration (ACTD), has already proven itself as a superb gap filler, and it will continue to be an important method of developing innovative warfighting capability in the future. The most important aspect of the ACTD is its ability to capture the lead warfighters' ideas early.

As mentioned in Chapter 2, ACTDs have proven to be a great source of gap fillers since the Predator was first deployed in the Balkans. In light of the subsequent research related to the sources of innovation, this should be no surprise. The primary function of the ACTD is to allow the warfighters to make an early determination as to whether the system provides value-added

combat capability before deeming the system worthy of a full acquisition program. Employing these systems in combat provides critical feedback from the lead warfighters, not in a written report or via a briefing or teleconference, but in everyday, face-to-face discussions between the lead warfighters and acquisition professionals. This level of collaboration and capture of lead warfighters' ideas and innovations is something that cannot be achieved through normal test and evaluation. For this reason, it is important the Air Force not shy away from employing ACTDs in combat operations and should examine how other immature non-ACTD programs might be used during combat operations.

Just as deploying the ACTD system to combat enables the developers of that weapon system to benefit from the lead warfighters' ideas and innovations, so to will future systems acquired under the concept of spiral development benefit from similar warfighter interaction. The earlier the lead warfighters are able to operate and evaluate the new systems, the earlier the acquisition community will be able to capitalize on the ideas and innovations of those lead warfighters.

In sum, the conclusions and recommendations of this research paper can be boiled down to one common theme—there must be an increase in collaboration between the acquisition and warfighting communities. While formal processes for filling capability gaps already exist, today's transformational environment provides the perfect time to break the mold and institute improvements. The changes recommended above will move the Air Force down the path of increased collaboration while also providing a framework from which the Secretary of Defense can respond to Congressional direction outlined in Sections 806 and 807 of the FY2003 National Defense Authorization Act. Collaboration will help bridge the gap between what can be antithetical cultures and help ensure the U.S. Air Force maintains dominance over future adversaries.

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